Satellite Communications

Overview of Satellite Systems

Lecture 1

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EEC 4122 – Fall 2016

Tanta

University

Course information

- Lectures:
  - **Four-hour** lecture per week
  - Lecture time slots: Sunday **(8:30 ~ 10:30) +** Tuesday **(8:30 ~ 10:30)**
  - **PPT-based lectures** are mainly used throughout this course and white board is used for further explanation
- Tutorials:
  - **Two-hour** tutorial per week
  - Tutorial time slots: check the Department schedule
  - Tutorials will cover assignments associated with different course topics
  - Assigned TA: Eng. Maram
- Office Hours:
  - Tuesday **(12:30 ~ 2:30)**

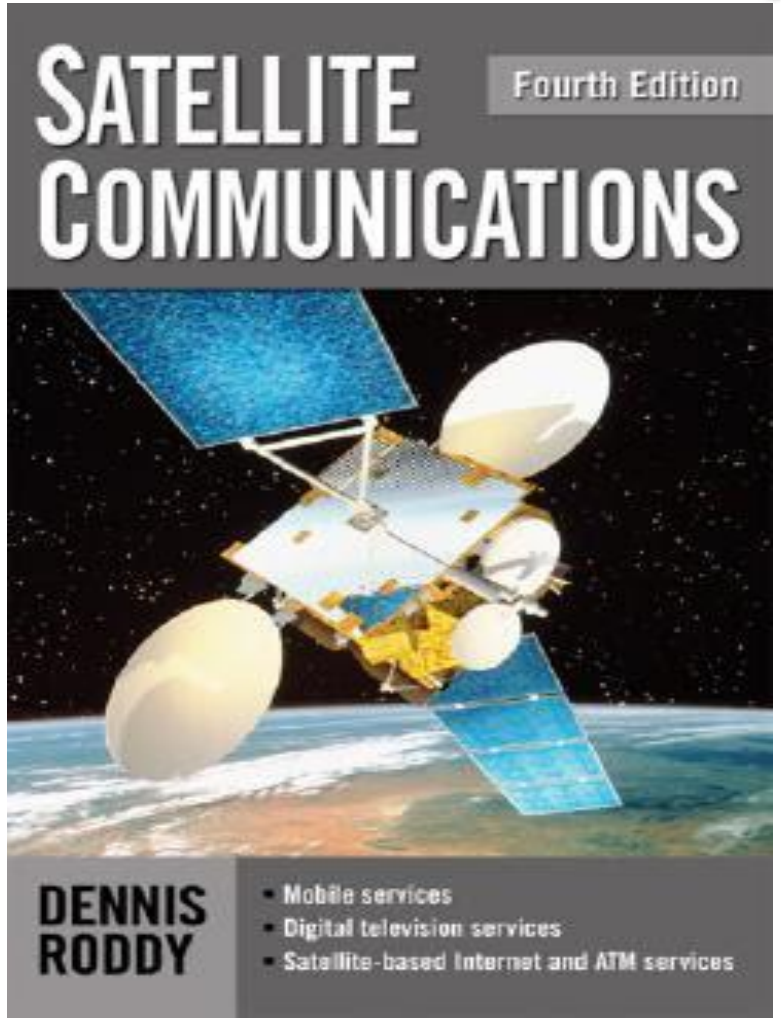
Course Objectives

- This course aims to cover the following topics
  - Overview of Satellite Systems
  - Orbits and launching
  - Geostationary Orbits
  - Space and Earth Segments
  - Satellite radio wave propagation
  - The space link
  - Satellite Mobile and Specialized Services
  - GPS Navigation System

Course teaching materials

- <u>Reference:</u>
- **SATELLITE COMMUNICATIONS**, DENNIS RODDY (4th Edition)

- There will be lecture notes on course topics (TBD)



Introduction

- In many homes for reception of satellite television
- Carrying large amounts of data in addition to television signals
- Advantages over other communication methods:
  - Very large earth areas are visible from satellite
  - Connecting very widely geographically separated users on earth
  - Reaching remote communities
  - No political boundaries
- Launching Cost is high but "**distance insensitive**" so it should be wisely used to be economical
- Satellite are used for remote sensing: **water pollution detection, weather conditions**

Frequency Allocations for Satellite Services

- Carried out by ITU
- World is divided into three regions:
  - Region 1: Europe, Africa, Russia
  - Region 2: North and South America and Greenland
  - Region 3: Asia, Australia, and the south west Pacific
- Each of the following satellite services are allocated a frequency band
  - Fixed Satellite services (FSS): telephone, cable TV
  - Broadcast satellite services (BSS): DBS
  - Mobile satellite services: maritime mobile
  - Navigation service: GPS
  - Meteorological service: rescue and search

Frequency Allocations for Satellite Services

- Satellite Frequency band designations (UpLink/DownLink)

TABLE 1.1 Frequency Band Designations

Frequency range, (GHz)	Band designation	
0.1–0.3	VHF	→ For weather satellites
0.3–1.0	UHF	
1.0–2.0	L	→ For mobile/navigation
2.0–4.0	S	
4.0–8.0	C	→ For FSS (6/4)
8.0–12.0	X	
12.0–18.0	Ku	For DBS (14/12)
18.0–27.0	K	
27.0–40.0	Ka	
40.0–75	V	
75–110	W	
110–300	mm	
300–3000	μm	

INTELSAT

- International Telecommunications Satellite (organization)
- 140 member countries
- providing end-to-end solutions through a network of teleports, leased fiber, and *points of presence* (PoPs)
- satellites are in ***geostationary*** *orbit*
- INTELSAT covers three main regions: AOR, IOR and POR

- Recent INTELSAT Satellite

TABLE 1.3 INTELSAT Geostationary Satellites

Satellite	Location	Number of transponders	Launch date
901	342°E	Up to 72 @ 36 MHz in C-Band Up to 27 @ 36 MHz in Ku Band	June 2001
902	62°E	Up to 72 @ 36 MHz in C-Band Up to 23 @ 36 MHz in Ku Band	August 2001
903	325.5°E	Up to 72 @ 36 MHz in C-Band Up to 22 @ 36 MHz in Ku Band	March 2002
904	60°E	Up to 72 @ 36 MHz in C-Band Up to 22 @ 36 MHz in Ku Band	February 2002
905	335.5°E	Up to 72 @ 36 MHz in C-Band Up to 22 @ 36 MHz in Ku Band	June 2002
906	64°E	Up to 72 @ 36 MHz in C-Band Up to 22 @ 36 MHz in Ku Band	September 2002
907	332.5°E	Up to 72 @ 36 MHz in C-Band Up to 23 @ 36 MHz in Ku Band	February 2003
10-02	359°E	Up to 70 @ 36 MHz in C-Band Up to 36 @ 36 MHz in Ku Band	June 2004

U.S. Domsats

- United States domestic satellite (within U.S.)
- Domsats are situated in geostationary orbit
- TV channel and commercial telecommunication traffic
- U.S. Domsats can be classified into: High, medium and low power

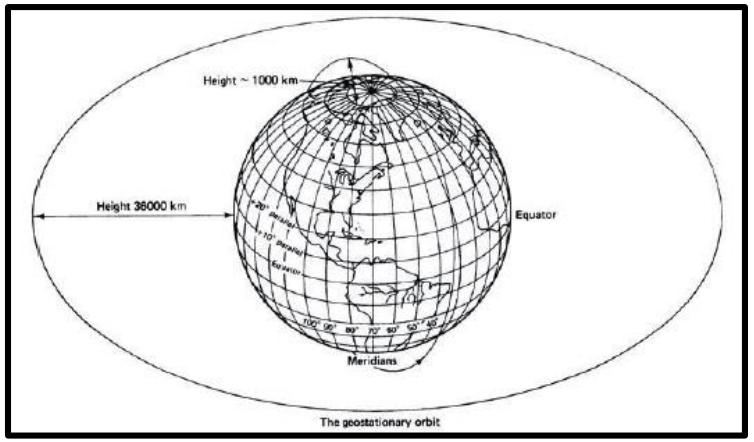
- Categories of U.S. Domsats

TABLE 1.4 Defining Characteristics of Three Categories of United States DBS Systems

	High power	Medium power	Low power
Band	Ku	Ku	C
Downlink frequency allocation GHz	12.2–12.7	11.7–12.2	3.7–4.2
Uplink frequency allocation GHz	17.3–17.8	14–14.5	5.925–6.425
Space service	BSS	FSS	FSS
Primary intended use	DBS	Point-to-point	Point-to-point
Allowed additional use	Point-to-point	DBS	DBS
Terrestrial interference possible	No	No	Yes
Satellite spacing degrees	9	2	2–3
Satellite spacing determined by	ITU	FCC	FCC
Adjacent satellite interference possible?	No	Yes	Yes
Satellite EIRP range (dBW)	51–60	40–48	33–37
	DBS	**P-to-P**	**TVRO**

Polar Orbiting Satellites

- orbit the earth in such a way as to cover the north and south polar regions



- Relatively low orbits (800~900 Km) → LEO Satellites
- Orbits are almost circular
- Can track weather conditions over the entire earth

- Orbits are sun synchronous, meaning that they cross the equator at the same local time each day

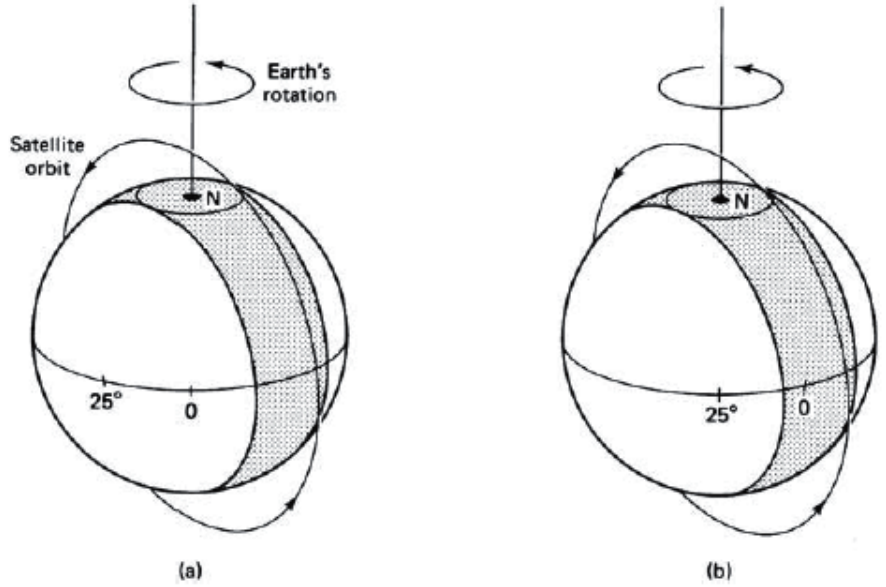


Figure 1.7 Polar orbiting satellite: (*a*) first pass; (*b*) second pass, earth having rotated 25°. Satellite period is 102 min.

- Can track weather conditions

Argos System

- Data collection system (Polar orbiting)
- Collects environmental data from platform transmitter terminals (PTT)
- Transmitters can be installed on many kinds of platforms, including fixed and drifting buoys, balloons, and animals
- PTTs transmit automatically at preset intervals, and those within the 6000 km swath are received by the satellite
- Doppler shift in the frequency received at the satellite is used to determine the location of the PTT

• Cospas-Sarsat (Russian System)